STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR ROAD BRIDGES

SECTION-IV
BRICK, STONE AND CEMENT CONCRETE BLOCK MASONRY
(THIRD REVISION)

INDIAN ROADS CONGRESS
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CONTENTS

S. No.	Description	Page No.
	Personnel of the Bridge Specification and Standards Committee (BSS)	i-ii
	Introduction	1
400	Scope	3
401	Definitions	3
402	Materials	7
403	Design Considerations	11
404	Planning Construction and Workmanship	15
405	Expansion Gap	25
406	Floor Protection Works	25
	Annexure-A	26

LIST OF TABLES

Table 2.1: Cement Specifications 8

Table 3.1: Permissible Compressive Stresses in Masonry 12

Table 3.2: Permissible Tensile Stresses 12

Table 3.3: Minimum Top width of Piers 14

LIST OF FIGURES

Fig.1.1: Lap of Vertical Joints in the Adjacent Courses 3

Fig.1.2: Coursed Rubble Stone Masonry (First Sort) 4

Fig.1.3: Coursed Rubble Stone Masonry (Second Sort) 4

Fig.1.4: Parts of an Arch 5

Fig.1.5: Joggle Joint 6

Fig.1.6: Rebated or Lapped Joint Sectional Elevation 7

Fig.4.1: English Bonds in Brick Masonry 17

Fig.4.2: Schematic Plan Showing Arrangement of Stones/Block in Arch Construction 24

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STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR ROAD BRIDGES

SECTION-IV

BRICK, STONE AND CEMENT CONCRETE BLOCK MASONRY

(THIRD REVISION)

INTRODUCTION

The Standard Specification and Code of Practice for Road Bridges Section-IV (Brick, Stone and Cement Concrete Block Masonry) was first published in 1970. The first revision of this document was published in the year 1995. The draft of the second revision of the document was taken up by the then B-8 Committee and finalized in February 1999. The document was published in 2002.

The BSS committee mandated IRC B-3 committee to take up the review and revision of "IRC:40-2002 Standard Specifications and Code of Practice for Road Bridges Section-IV Brick, Stone and Cement Concrete Block Masonry".

The B-3 committee constituted a sub-committee under the chairmanship of Shri M.P. Marwah with Dr. S.S. Gaharwar, Dr. B.K. Maheshwari, Sh. Rajib Chattraj, Sh. Rajesh Chandra and Sh. D.K. Rastogi to review the existing document and suggest revisions required. The sub-committee held a number of meetings and finalized the revision and forwarded it to the B-3 committee. The B-3 committee considered the draft in its various meetings. During the 17th meeting of B-3 committee held on 13.04.2023, the committee approved the draft revision of IRC:40 with certain observations and authorized the convener to finalise and send the draft revision to BSS for approval. The composition of B-3 committee is as under:

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Basa, Ashok	.....	Co-Convenor
Mayur, P.V.	.....	Member-Secretary

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Ministry of Road
Transport & Highways

Secretary General,
Indian Roads Congress
(Nirmal, S.K.)

The draft revision was considered by BSS committee in its meeting held on 28.06.2023 wherein it was desired that the draft be first reviewed by a standing committee before submitting to BSS committee. The Technical Standing Committee comprising of Shri Ashok Basa, Dr. S.S. Gaharwar & Shri P.V. Mayur in its meeting held on 05.11.2023 recommended the draft revision for placing before BSS committee for its consideration. The BSS committee in its meeting held on 18.11.2023 after due deliberations approved the document for placing before the Executive Committee & IRC Council. The Executive Committee in its meeting held on 1st December, 2023 approved the same for placing before IRC Council. The IRC Council in its 226th meeting held on 02.12.2023 at Gandhinagar (Gujarat) approved the draft revision for printing.

The existing document is more than 20 years old. During this period a number of BIS, IRC and other codes used in this code have changed. The Ministry's Specifications for Roads and Bridge Works has also been revised and is under further revision. In this revision the following major changes have been made:

i) Culverts have been included.
ii) Definitions covered in IRC:5 "Standard Specifications and Code of Practice for Road Bridges, Section I – General Features of Design" have been deleted.
iii) Provisions updated as per latest BIS codes.
iv) All types of bricks as per relevant BIS codes have been included.
v) In Seismic zones IV and V span length is restricted to 10 m as per provision of clause 219.1.3 of IRC 6 "Standard Specifications and Code of Practice for Road Bridges, Section-II Loads and Load Combinations".
vi) Ashlar stone masonry added.

400 SCOPE

This code deals with the structural use of bricks, stones, cement concrete blocks and fly ash blocks in masonry in the construction of culverts and bridges up to 15 m span length.

Though this code does not cover the masonry work done during freezing weather, precautions for the same may be taken as outlined in **Annexure-A** of this code.

This code is based on the working stress method of design.

401 DEFINITIONS

The definitions of commonly used terms are given in IRC:5, which may be referred. The definitions of additional terms specific to this code are given hereunder:

401.1 Abutment

Deleted. Refer IRC:5.

401.2 Ashlar Masonry

A masonry made of squared building stones cut more or less true on all faces adjacent to those of other stones, to permit very thin mortar joints.

401.3 Bond

Arrangement of brick/stones in successive courses to tie the masonry together both longitudinally and transversely i.e. to ensure stability and greatest amount of lap. The lap shall not be less than half the height of course **(Fig.1.1).**

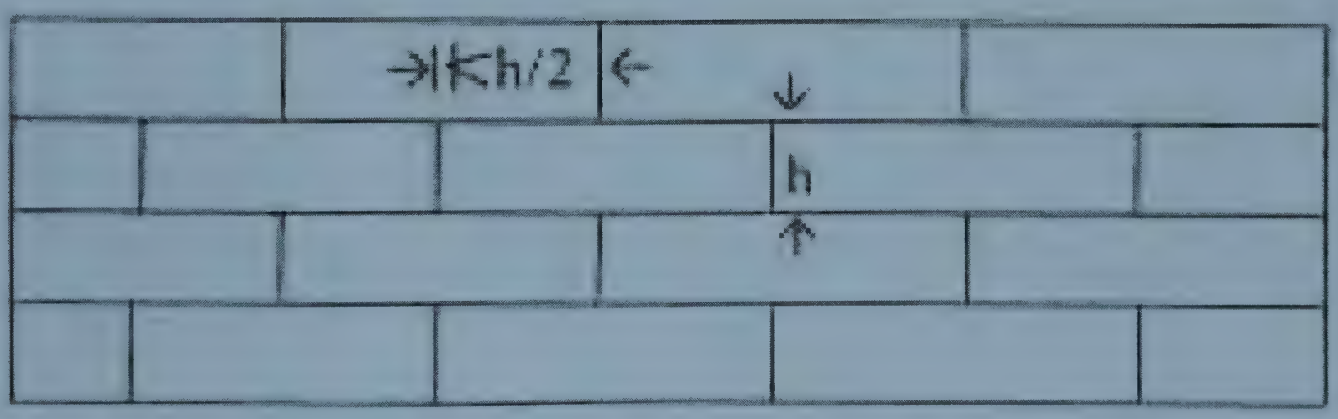

Fig. 1.1 Lap of Vertical Joints in the Adjacent Courses

401.4 Bond Stone

Bond stones are selected long stones used to hold a wall together transversely.

401.5 Coursed Rubble Masonry (First Sort)

In this type of masonry, face stones are dressed and all the stones are laid in courses which are of equal height unless otherwise specified. The height of the stone is equal to the height of the course **(Fig.1.2)**. For details MORT&H specifications may be referred.

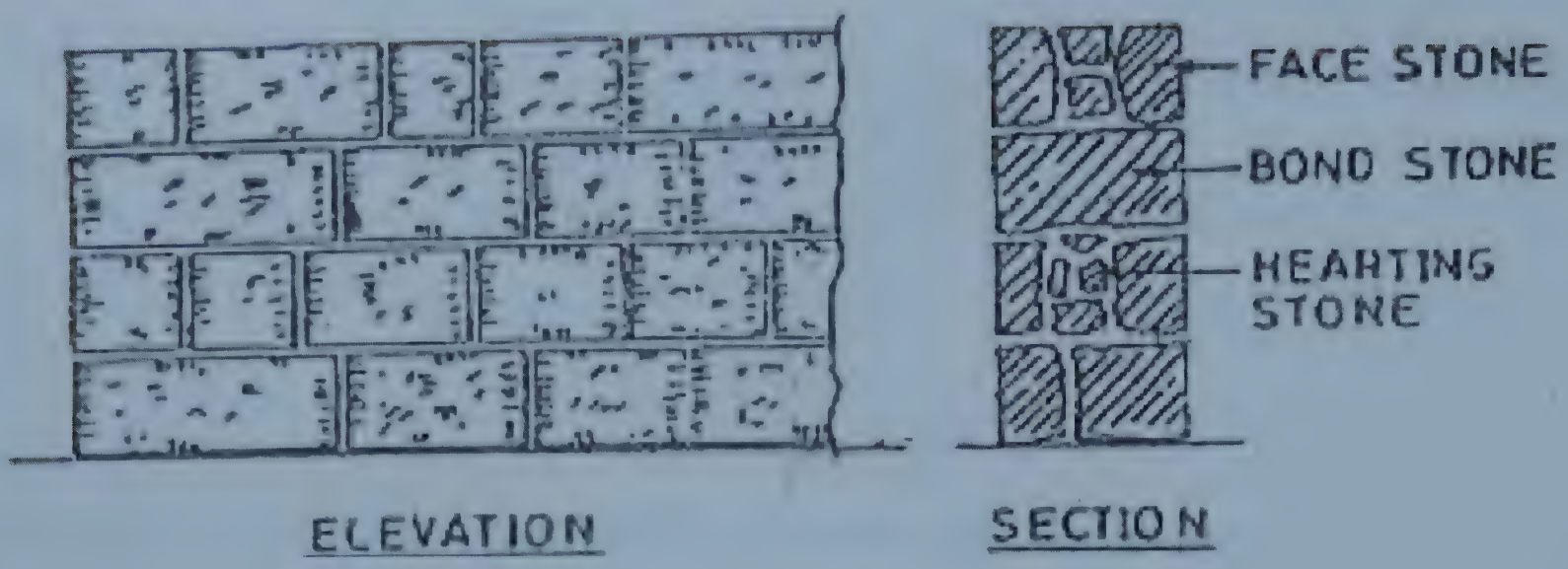

Fig. 1.2 Coursed Rubble Stone Masonry (First Sort)

401.6 Coursed Rubble Stone Masonry (Second Sort)

In this type of masonry, courses shall be of uniform height throughout. In any course, all the stones may not be of height equal to that of the course, but not more than two stones are used to constitute a course at any place **(Fig.1.3)**.

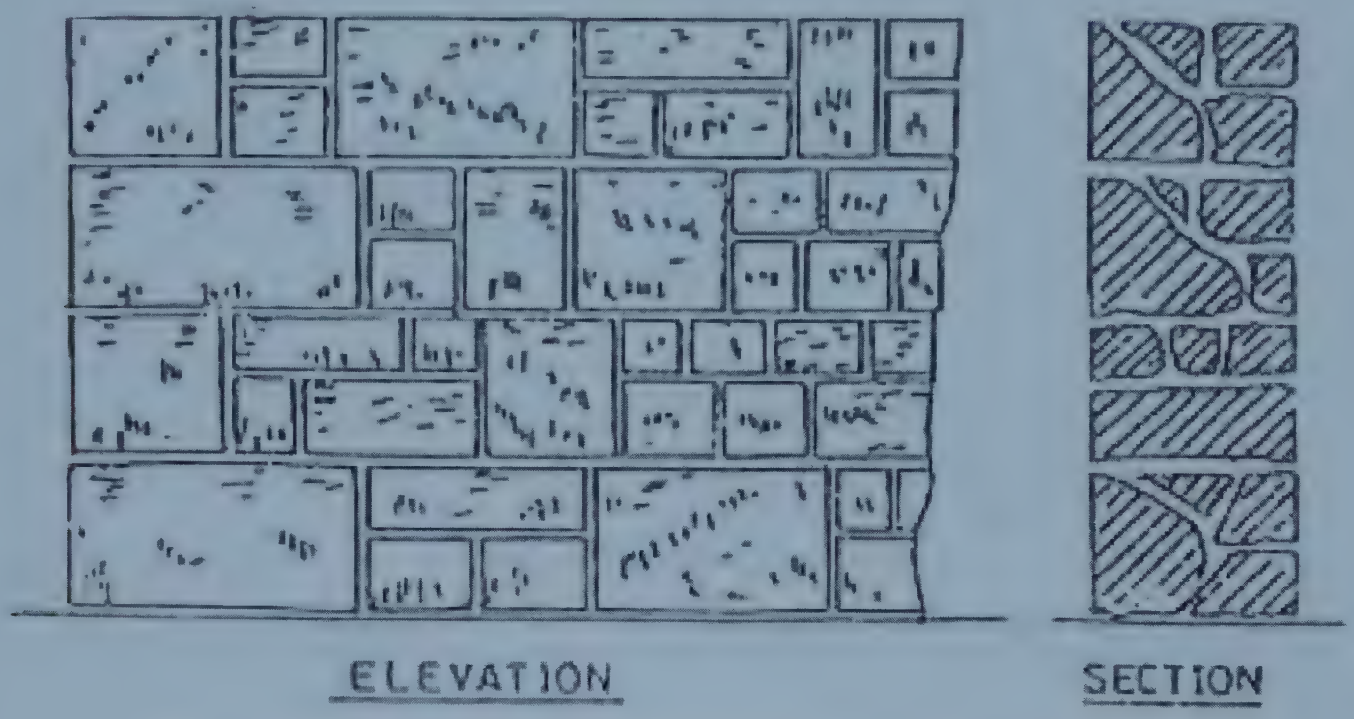

Fig. 1.3 Coursed Rubble Stone Masonry (Second Sort)

401.7 Cushion

Cushion is the material placed over the Arch/Pipe and its depth is measured from the top of the crown to the top of the road surface.

Deleted- as this item is not used in this code.

401.8 Extrados or Back Curve of the Arch

This is the external curve of the arch as shown in **Fig.1.4**.

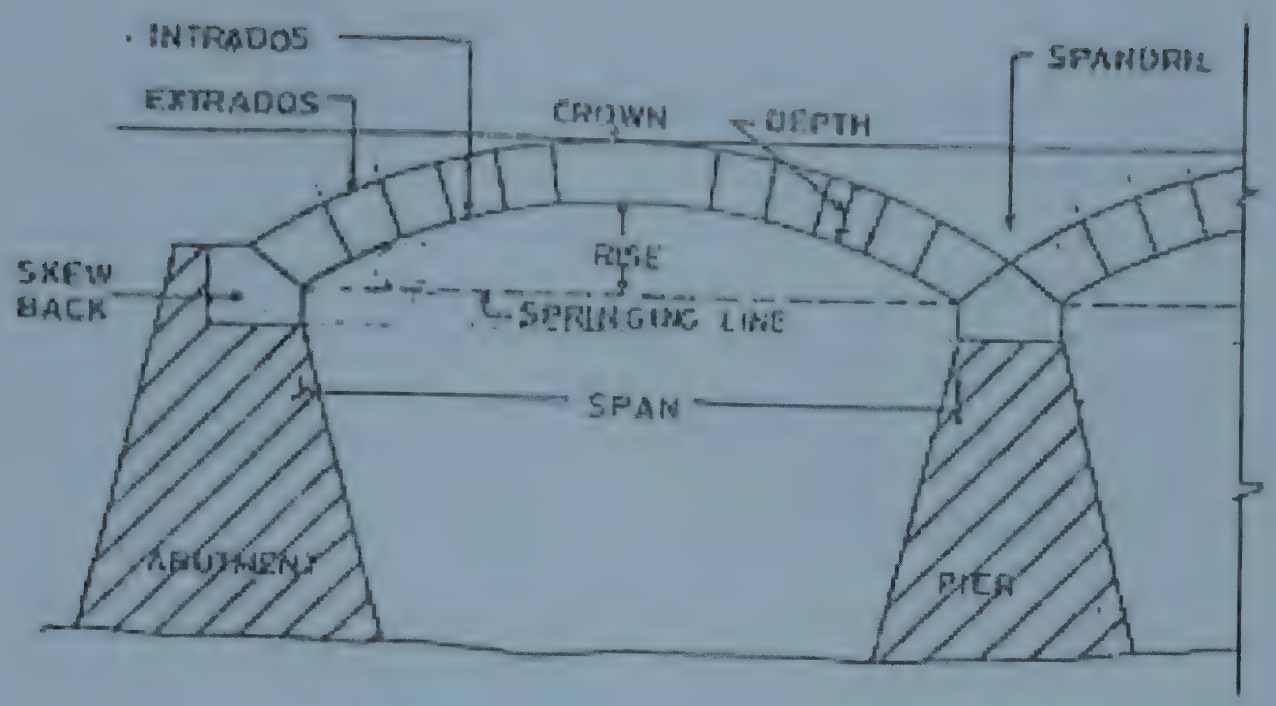

Fig. 1.4 Parts of an Arch

401.9 Face Stone

Stones used in the face of masonry.

401.10 Footings

The projected courses below the base of a pier, or an abutment meant to distribute the load on the founding strata.

401.11 Gauge

Gauging means chipping or rubbing bricks or stones to form a uniform size or shape.

401.12 Hardening Time

The duration in which masonry gains 80% of ultimate strength.

401.13 Header Stone

A block/stone laid with its length (Dimension perpendicular to face) across the wall. The length shall not be less than twice the height of the course.

401.14 Hearting Stone

The hearting stones are the stones used for interior filling of a wall.

401.15 Intrados

This is inner curve of the arch (Refer, **Fig.1.4**).

401.16 Intermediate Heavy Pier

In case of multiple span arch bridges, every third to fifth pier is provided with a heavier section designed for one span dislodged condition so as to limit the cascading effect of the failure of any one span to the unit. Such a pier is called an intermediate heavy pier.

401.17 Joggle Joint

This refers to a joint where grooves are provided on one stone to fit to a corresponding projection in the adjacent stone **(Fig.1.5).**

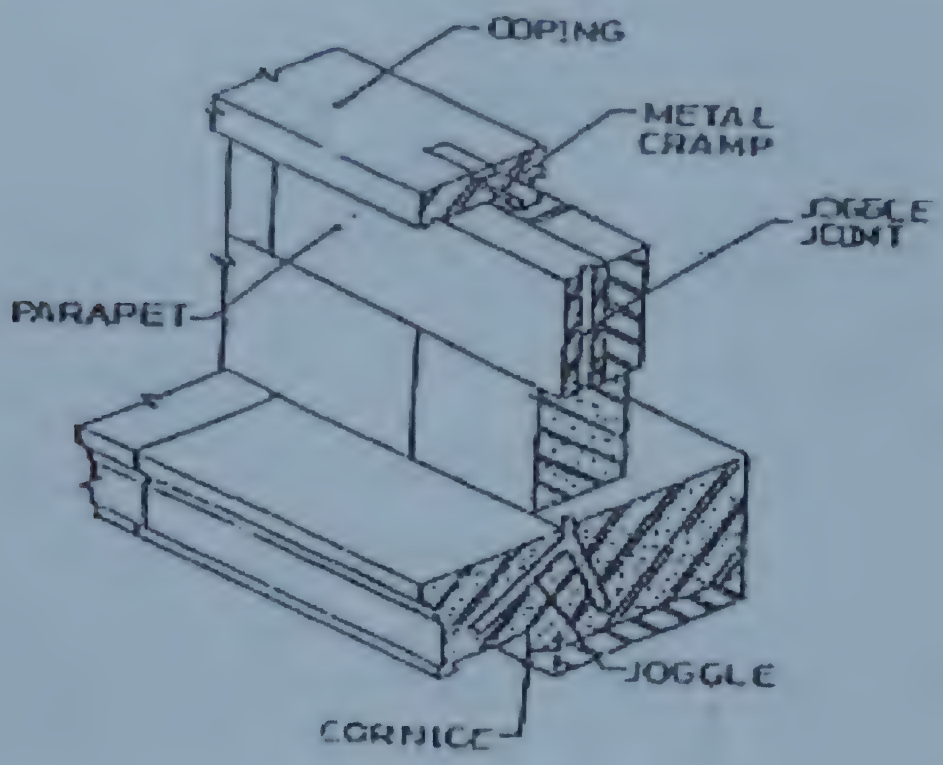

Fig. 1.5 Joggle Joint

401.18 Major Bridge

Deleted. Refer, IRC:5.

401.19 Masonry

An assemblage of bricks, cement concrete blocks, fly ash blocks, and natural stones dressed or undressed bonded together with mortar.

401.20 Pier

Deleted. Refer, IRC:5.

401.21 Plum Stone/Pin Headers

These are selected oblong stones embedded vertically in the interior of masonry to form a bond between successive courses. Their length shall be twice the length of each course of masonry.

401.22 Quoin Stone

A quoin is the external angle of wall. Quoin stone is specially selected and neatly dressed stones for forming such angle.

401.23 Random Rubble Masonry

This type of masonry is constructed out of stones as they come from the quarry directly. It is generally not constructed in regular courses.

401.24 Rebated or Lapped Joint

In this type of joint, rebates are provided in adjacent stones which lap over each other to prevent movement of stone refer **(Fig.1.6).**

Fig. 1.6 Rebated or Lapped Joint Sectional Elevation

401.25 Retaining Wall

Deleted. Refer, IRC:5.

401.26 Return Wall

Deleted. Refer, IRC:5.

401.27 Spalls

These are chips or small stones used for packing up and filling the interstices in the masonry.

401.28 Spandril

The space formed between the extrados and the horizontal line drawn tangent to crown (Refer **Fig.1.4**).

401.29 Squint Brick/Stone

Bricks/stones used for forming an acute or obtuse corner in brick/stone masonry.

401.30 Toe Wall

Deleted. Refer, IRC:5.

401.31 Wing Wall

Deleted. Refer, IRC:5.

402 MATERIALS

The mentioned materials used in construction should comply with the relevant provisions and clauses of appropriate codes of practices.

402.1 Cement

The cement to be used shall conform to the relevant specifications as given in **Table 2.1**.

Table 2.1 Cement Specifications

Sl. No.	Type of Cement	In Accordance with
1.	33 Grade Ordinary Portland Cement (OPC)	IS: 269
2.	43 Grade Ordinary Portland Cement (OPC)	IS: 269
3.	53 Grade Ordinary Portland Cement (OPC)	IS: 269
4.	Portland Slag Cement (PSC)	IS: 455
5.	Portland Pozzolana Cement (PPC) (Fly Ash based)	IS: 1489 (Part-1)
6.	Sulphate Resistant Portland Cement (SRPC)	IS: 12330
7.	Rapid Hardening Portland Cement	IS: 8041
8.	Low Heat Portland Cement	IS: 12600

Notes: *1.OPC grade 43 and 53 generate higher heat of hydration. If either of these cements is used, special precautions shall be taken for curing of structure.*

2.Use of Sulphate Resistant Cement may be warranted where the Masonry Structure is likely to be affected by the presence of excessive Sulphates in the surrounding soil/water.

IS Codes wherever referred, shall be the latest IS Code.

402.2 Lime

Lime may be used as a part of composite mortar. Lime to be used shall conform to specifications of type Class-A or Class-B of IS: 712.

402.3 Bricks

The bricks to be used shall conform to the following specifications:

402.3.1 *Burnt Clay Bricks*

i) Common burnt clay bricks conforming to IS: 1077, or
ii) Heavy duty burnt clay bricks conforming to IS: 2180.

402.3.2 *Fly Ash Bricks*

i) Pulverised Fly Ash-Lime bricks conforming to IS: 12894, or
ii) Burnt Clay Fly Ash Building Bricks conforming to IS: 13757.

402.3.3 *Fuel Ash Bricks*

i) Pulverised Fuel Ash-Cement Bricks conforming to IS: 16720.

402.3.4 *Calcium Silicate Bricks*

i) Calcium Silicate Bricks conforming to IS: 4139.

The bricks shall be of classification 15 or higher (Average compressive strength when tested as per IS: 3495 not less than 15 MPa). Pulverized fuel ash shall conform to IS: 3812 (Grade A or Grade B). The tolerances shall be within the limits specified in relevant BIS codes referred to above for the respective type of brick.

Note: *For building works the bricks of classification 7.5 and above may be used as per CPWD specifications.*

402.4 Stone

The Stone used shall conform to the relevant specifications of IS: 1597 (Part-I) – Code of Practice for Construction of Rubble Stone Masonry, and Part-II- Ashlar Stone Masonry.

Samples of Natural Building Stones shall be tested for Strength Properties as per IS: 1121 (Part-1, Part-2, Part-3, Part-4). Samples of stone shall be tested for water absorption and porosity as per IS: 1124. The compressive strength of stone shall not be less than 20 Mpa.

402.5 Blocks

402.5.1 Solid Concrete Blocks made of Cement and suitable aggregates shall conform to relevant provisions of IS: 2185 Part-I and Clause No. 1405.2 of MoRT&H Specifications. The Compressive Strength of solid Concrete Blocks shall not be less than 20MPa. Precast Concrete Blocks made with Recycled Aggregates shall comply with the requirements of IS: 383 and IS: 2185. However, it shall be ensured that their compressive strength when tested as per IS: 2185 is not less than 20 MPa, and blocks are prepared under expert guidance.

402.5.2 Hollow lightweight concrete blocks shall not be used.

402.6 Sand/Stone Dust/Marble Dust

Sand/stone dust/marble dust, etc., shall consist of hard, durable clean particles of natural sand, crushed gravel, crushed marble or suitable combination of natural sand and crushed gravel. This shall not contain dust lumps, soft or flaky particles, mica and other deleterious materials in such quantities as would reduce the strength or durability of mortar. Fine aggregates including the Recycled Fine Aggregates shall conform to IS:383 and IS:2116.

402.7 Water

Water used for washing of aggregates, mixing and curing shall be clean and free from oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Testing of water shall comply with IS: 456 and IS: 3025 (Part-17, Part-18, Part-32). Potable water is generally considered satisfactory for mixing Cement Mortar. To avoid any harmful chemical effects of water, its pH value shall not be less than 6. Mixing and curing with seawater shall not be permitted.

402.8 Storage

All materials shall be stored so as to prevent their deterioration and intrusion of foreign matter and preserve their quality and suitability for the work. Any material, which has deteriorated or has been damaged or is otherwise considered unsuitable by the Engineer, shall not be used on the work.

402.8.1 *Cement*

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and

water-tight sheds and shall be stacked to a height of not more than eight bags. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site. The containers shall be cleaned at least once every 3 months.

Cement shall be used in the sequence in which it is delivered at site. Each consignment shall be stored separately so that it may be readily identified and inspected. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site.

Proper records shall be maintained at site in respect of delivery, handling, storage and use of cement.

402.8.2 *Lime*

Lime shall be stored in weatherproof sheds. Lime, affected by rain, moisture or air slaking, shall not be used. Hydrated lime shall be stored in the same manner as in the case of cement and the storage period shall not be more than one month.

402.8.3 *Bricks*

Bricks shall not be dumped at site. They shall be stacked in regular tiers as to minimise breakage and defacement. Quantity of bricks shall be such that at least the demand of bricks for construction of two days can be readily met with it at the site at any given time. Bricks selected for use in different situations shall be stacked separately.

402.8.4 *Fine Aggregate*

Fine aggregates, viz., sand, stone dust, marble dust, etc. shall be stored in such a way as to prevent admixture of foreign materials. It should be stored such that wind, etc. may not affect its purity.

402.8.5 *Water*

Water shall be stored in covered containers/tanks and cleared at regular intervals in order to prevent intrusion of foreign matter or growth of organic matter. Use of water from shallow, muddy or marshy sources shall not be permitted. The intake pipe shall be suitably enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

403 DESIGN CONSIDERATIONS

403.1 General

i) The general dimensions and features shall be in accordance with the provisions given in the IRC:5.
ii) Masonry bridges shall not be provided where individual span lengths exceed 15 m or the height of masonry above foundation up to the top of pier/abutment cap, is more than 10 m.
iii) Generally, the masonry structures shall be constructed in coursed rubble or ashlar masonry.
iv) Random rubble masonry shall be used only in the construction of return, wing and toe walls with heights up to 5 m.

In seismic zones IV and V, masonry arch bridges shall not have span more than 10 m.

403.2 Design

i) The provisions given in subsequent clauses are on working stress basis.
ii) Loads and forces for the design of components may be evaluated as per IRC:6.
iii) Combination of loads and forces for the design of foundations shall as per IRC:78 (Part-1).
iv) Permissible overstress in masonry shall be in accordance with Clause 403.7.
v) For stability check, respective provisions in IRC:78 (Part-1) shall be applicable.

Design discharge, scour depth, etc. may be worked out as per IRC:5.

403.3 Load Dispersion

403.3.1 *Footings*

The dispersion of load through the masonry shall be considered at 45 degrees to the vertical.

403.3.2 *Over Arches*

For arch bridges, the load shall be taken as dispersed at an angle of 45 degrees to the vertical through the road surface and the filling material upto the level of extrados of the arch. Filling material in the cushion shall have minimum 12 % C.B.R. and good drainage property. The earthen cushion above the crown shall not be less than 500 mm. In respect of submersible bridges, the cushion shall be of P.C.C. and the minimum thickness shall be 300 mm. The dispersion of load through the concrete cushion shall also be taken at an angle of 45 degrees.

403.4 Permissible Compressive Stress Under Direct Compression

403.4.1 The permissible compressive stress depends upon the crushing strength of the structural units, viz., bricks, blocks, or stones, and the grade of mortar used and it shall be related to the values as given in **Table 3.1**.

Table 3.1 Permissible Compressive Stresses in Masonry

Mortar Mix (Parts by Volume)			Hardening Days after Completion of Work	Compressive Strength of Brick/Stone/Block (MPa)				
				15	20	25	30	35 or more
Cement	Lime	Sand	Days	Permissible Compressive Stresses in Masonry (Mpa)				
1	-	3	7	1.40	1.64	1.94	2.22	2.50
1	-	4	14	1.20	1.44	1.73	1.98	2.20
1	-	5	14	1.10	1.36	1.57	1.79	2.00
1	0.5	4.5	14	1.40	1.64	1.94	2.22	2.50

Note: *1. Linear interpolation of the permissible compressive stresses is permissible for the units whose compressive strength lies between the given values in the Table 3.1.*

2. The stress values given above are valid for coursed rubble masonry and ashlar masonry.

3. For random rubble masonry conforming to IS: 1597 (Part-I), the permissible stresses shall be 67% of the values given above.

403.4.2 For arch rings, the permissible compressive stress shall not be more than 1.64 MPa. However, where Ashlar stone masonry is used, the maximum permissible stress shall be as per **Table 3.2**.

403.5 Permissible Tensile Stress

The permissible tensile stress in brick, block or stone masonry shall be in accordance with the values given in **Table 3.2**.

Table 3.2 Permissible Tensile Stresses

		Permissible Tensile Stress in MPa			
Sl. No.	Type of Masonry	Mortar with Cement Sand Ratio			Mortar with Cement, Lime, Sand Ratio
		1:3	1:4	1:5	1.0:0.5:4.5
1.	Brick	0.14	0.10	0.07	0.12
2.	Block	0.10	0.07	0.05	0.10
3.	Stone	0.10	0.07	0.05	0.10

403.6 Permissible Shear Stress

The permissible shear stresses in brick/stone masonry shall be taken as the greater of the two values specified in (i) and (ii) below but shall not exceed 0.2 MPa.

i) Same as values of allowable tensile stresses given in **Table 3.2**.
ii) One-third of compressive stresses produced by dead load only at the level under consideration.

Note: *The above values shall be reduced by 20% in the design of the substructure of arch bridges.*

403.7 Combination of Loads and Forces

Deleted as already covered in Clause 403.2.

403.8 Permissible Overstress

403.8.1 When components are subjected to eccentric loading and or lateral forces maximum compressive stresses resulting from combination of stresses due to axial loading, eccentric loading and due to lateral forces may exceed the stresses given in **Table 3.2** up to 25% provided that such excesses are only due to eccentricity of loading and/or due to lateral forces excluding seismic forces.

403.8.2 For combination of loads and forces including seismic force, the resulting compressive stresses may exceed the stresses given in **Table 3.2** up to 50%.

403.8.3 In seismic conditions, tensile stress given in **Table 3.3** may be increased by 20%.

Note: *Clause 403.8.1 and Clause 403.8.2 shall not be applicable at the same time.*

403.9 Foundation Design

403.9.1 *Open Foundations*

The foundations shall be checked for:

i) Sliding
ii) Overturning
iii) Base pressure
iv) Global stability

The factor of safety to be ensured under the worst combinations of loads shall be as given in IRC:78 (Part-1).

403.9.2 *Well Foundations*

Masonry well foundations shall be designed as per IRC:78 (Part-1). The compressive strength of the bricks used in well foundations shall not be less than 20 MPa.

403.10 Sliding

While checking the stability against sliding, coefficient of friction between interfaces of masonry, shall be taken as 0.6 unless specified otherwise.

403.11 Pier, Abutment, Return and Wing Walls

403.11.1 The thickness of pier/abutment return/wing walls shall be sufficient to ensure that in any section stresses due to the worst combination of loads and moments, for which the structure is designed, are within the permissible limits prescribed.

403.11.2 *Top Width*

403.11.2.1 The minimum width at the top of piers and abutments for slab and girder bridges just below the caps are given in **Table 3.3** for guidance.

Table 3.3 Minimum Top width of Piers

Span in m.	<=3	>3<=6	>6<=12	>12<=15
Top width of piers with simply supported span (mm) and top width of all abutments (mm)	500	1000	1200	1600
Top width of pier with continuous span (mm)	400	750	1000	1300

403.11.2.2 In case of arch bridges, the top width of abutments and piers shall be adequate to accommodate skewbacks and to resist the stresses imposed under the most unfavourable conditions of loading.

403.11.2.3 The top width of wing walls and returns shall not be less than 450 mm.

403.11.3 For multiple-span arch bridges, intermediate heavy pier shall be provided after every third to fifth span.

403.11.4 The ratio of the height of the pier or abutment to its base width shall not be more than six.

403.11.5 When piers and abutments in masonry are constructed in rivers with velocity more than 4.5 m/sec and carrying highly abrasive particles, the following special precautions shall be taken:

i) Extra section thickness of 100 mm over and above the design thickness shall be provided as sacrificial thickness upto 0.5 m above the H.F.L.
ii) In case of stone masonry piers and abutments, the minimum height of the course shall be 250 mm.

403.11.6 *Weep Holes*

Adequate number of weep holes at spacing not exceeding 1 meter both in the horizontal and vertical direction and suitably staggered shall be provided to prevent any accumulation of water and building of the hydrostatic pressure behind the abutment, returns and wing walls. The lowest row of weep holes shall be provided 150 mm above low water level or lowest ground level whichever is higher. Weep holes shall be provided with 100 mm dia AC/PVC/HDPE pipes for structures in masonry. In stone masonry, weep holes can be circular (of 100 mm dia) or rectangular (80 mm x 150 mm). Weep holes shall be extended through the full width of masonry with slope of one vertical to 20 horizontal towards draining face. To ensure proper functioning of weep holes, a properly designed filter layer shall be placed behind the wall.

The pattern of the weep holes shall be predetermined to ensure its aesthetic appearance.

403.11.7 The wing wall at its end away from the abutment shall have minimum 600 mm height. This 600 mm height wall at the end shall further extend 600 mm in a direction parallel to traffic direction.

403.12 Caps

The width and thickness of the caps over masonry piers and reinforcement therein shall be in accordance with IRC:78 (Part-1).

403.13 Parapet Wall

The height of parapet wall shall be as per provisions of IRC:5. The mortar used shall be cement sand mortar in 1:3 proportion conforming to Clause 404. For submersible bridges, instead of parapet walls, either collapsible or removable type railings shall be provided in accordance with IRC:5. In case of causeways, guideposts can be provided in lieu of railings.

Discontinuous kerbs with 300 mm wide gap @ 1800 mm centre to centre (1500 mm continuous length of kerbs) should be provided with gaps of opposite kerbs kept in alignment with the flow for streamlining of flow.

403.14 Coping

Architectural coping shall be provided over the top of wing/ return/parapet walls. The minimum thickness of stone/concrete coping over stone masonry shall be 150 mm. For concrete coping, vertical joint at spacing of not more than 1.5 m shall be provided. In case of stone masonry, the mortar used shall be cement sand mortar in 1:3 proportion prepared conforming to Clause 404. Coping shall be sloping gently towards the outside for drainage of rainwater away from the earth fill.

403.15 Foundation Block

403.15.1 In case of soil base, a levelling course of 100 mm thickness in M-15 grade concrete shall be provided. Over the levelling course, a foundation block of minimum thickness of 300 mm and grade of concrete M-20 shall be laid before taking up the masonry work.

In case of rock base, a levelling layer of cement concrete with minimum average thickness of 150 mm and of minimum M-20 grade shall be provided. The stone masonry work can be started right above this layer.

403.15.2 For reinforcement, if any, used in the foundation block, relevant provisions of IRC:112 "Code of Practice for Concrete Road Bridges" shall be followed.

403.16 For Miscellaneous

For other items not covered in this code; reference may be made to IRC:78 (Part-1). IS code of practice wherever mentioned shall be latest addition of IS code.

404 PLANNING CONSTRUCTION AND WORKMANSHIP

404.1 Necessary Information

i) For efficient planning, design and execution of works, detailed information with regard to the following shall be furnished to those responsible for such works:
ii) Layout plan showing the orientation of the structure.
iii) Dimension details of the structure with details of sections and levels of foundation/ground levels, clear height from floor/ground level to soffit, size and span, etc.

iv) Type of stone/brick/block and class of masonry, types of bond and final finish for the masonry, the mix of the mortar to be used, etc., details of structural features, moulding and other special work.

v) Location and other details of embedments, like, water pipes, electrical pipes. weep holes and junction, etc.

404.1.1 *Mortar*

404.1.1.1 Proportioning and Mixing Mortar

Cement and sand shall be mixed in specified proportions given on the drawings. Cement shall be proportioned by weight, taking the unit weight of cement as 1.44 tonne per cubic meter. Sand shall be proportioned by volume with due allowance for bulking. Cement and sand shall be mixed dry in the required proportions to obtain uniform colour. The mortar shall be mixed with a minimum quantity of water to produce desired workability consistent with required density. The mix shall be clean and free from soil, acid, alkali, organic matter, or other deleterious substances.

The mixing shall be done in a mechanical mixer operated manually or by power. As an exception, hand mixing can also be resorted to as long as uniform density of the mix and its strength are assured. Hand mixing shall be permitted only for very small and isolated works like CD works, subject to the prior approval of the Engineer. Hand mixing shall be carried out on a clean watertight platform, where cement and sand shall be first mixed dry in the required proportion by being turned over and over, backwards and forwards, several times till the mixture is of uniform colour. Thereafter, minimum quantity of water shall be added to bring the mortar to the consistency of a stiff paste. The mortar shall be mixed for at least two minutes after addition of water.

Mortar shall be mixed only in such quantity as required for immediate use. The mix which has developed initial set shall not be used. Initial set of mortar with ordinary Portland Cement shall normally be considered to have taken place in 30 minutes after mixing. In case the mortar has stiffened during initial setting time because of evaporation of water, it shall be re-tempered by adding water as frequently as needed to restore the requisite consistency, but such re-tempering shall not be permitted 30 minutes after mixing. Mortar remaining unused for more than 30 minutes after mixing, shall be rejected and removed from the construction site.

For cement mortar gauged with lime, lime and sand shall be ground into mortar. Immediately before use, the specified proportion of cement shall be added to a small quantity of the mortar and intimately mixed for obtaining uniform distribution of cement. The cement mortar gauged with lime shall be used within half an hour of mixing cement.

404.1.1.2 Testing of Mortar

Necessary tests to determine compressive strength of the mortar, its consistency and water resistivity shall be carried out in accordance with IS: 2250. For compressive strength tests, the frequency of testing shall be 1 cube for every 2 cum of mortar prepared subject to a minimum of 3 cubes for a day's work.

It may be borne in mind that, in addition to compressive strength of mortar, its resistance against shear and also its adhesion or bond with masonry unit are factors which affect the strength of the mortar and of the masonry. The performance of mortar in this respect will depend not only upon the

bond developed in initial stages of hardening of mortar but also on extent to which bond is maintained in course of time where mortar is subject to effects of temperature variation and moisture movement. The factors governing strength of bond are elaborated in IS : 2250.

404.2 Brick Masonry

404.2.1 Brick masonry, in general, shall conform to the requirements of IS : 2212 "Code of Practice for Brick Work".

404.2.2 *Wetting of Bricks*

All bricks immediately before being laid, shall be thoroughly soaked in a tank filled with water, so as to have sufficient moisture to effect a proper bond between the brick and mortar. Minimum period of soaking prior to use shall be 1 hour. Soaked bricks shall be removed from the tank sufficiently in advance so that they are skin dry at the time of actual laying. Two tanks shall be provided one to soak the bricks and other to stack the soaked bricks to remove the excess water and make the bricks surface dry. Such soaked bricks shall be stacked at a clean place where these are not contaminated with dirt, soil etc.

404.2.3 *Laying*

All brickwork shall be laid in an English bond, even and true to line, plumb and level and all joints accurately kept in accordance with the drawing or as directed by the Engineer. Half and cut bricks shall not be used except when necessary to complete the bond. Closer in such cases shall be cut to the required size and used near the ends of the walls. The bricks used at the face and also at all angles forming the junction of any two walls shall be selected whole bricks of uniform size, with true and rectangular faces. **(Fig.4.1)**. The brick works shall conform to IS: 2212.

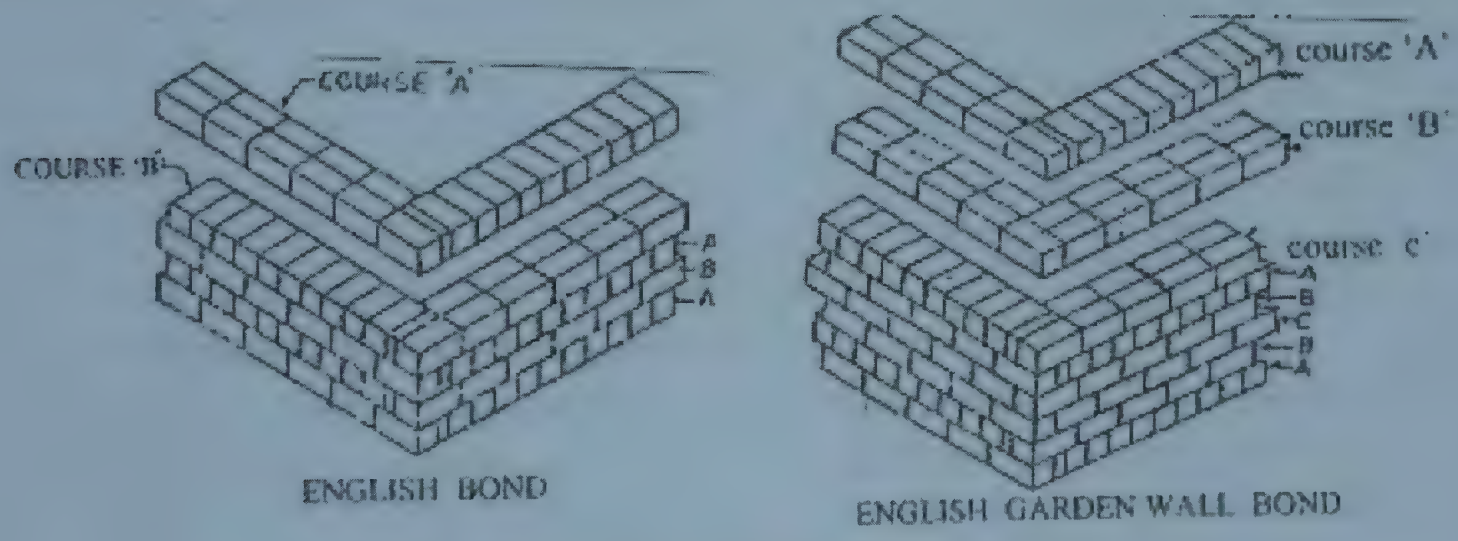

Fig. 4.1 English Bonds in Brick Masonry

All bricks shall be laid with frogs up on a full bed of mortar except in the case of tile bricks. Each brick shall be properly bedded and set in position by slightly pressing while laying, so that the mortar gets into all its surface pores to ensure proper adhesion. All head and side joints shall be completely filled by applying sufficient mortar to brick already placed and on brick to be placed. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left. No bats or cut bricks shall be used except to obtain dimensions of the different courses for specified bonds or wherever a desired shape so requires.

The brick work shall be built in uniform layers and for this purpose, wooden straight edge with graduations indicating thickness of each course including joint shall be used. Corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter. All courses shall be laid truly horizontal, and vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. During construction, no part of work shall rise more than one meter above the general construction level, to avoid unequal settlement and improper jointing. Where this is not possible, the work shall be raked back according to the bond (and not toothed) at an angle not steeper than 45 degrees with prior approval of the Engineer. Toothing may also be permitted where future extension is contemplated.

Laying Masonry in Foundation

Before laying bricks in foundation, the foundation slab shall be thoroughly hacked, swept clean and wetted. A layer of mortar not less than 12 mm thick shall be spread on the surface of the foundation slab before the first course of bricks is laid.

404.2.4 *Pointing*

In pointing, the joints shall be properly raked out to a depth of 15 mm while the mortar is still green. Pointing shall be carried out by using cement sand mortar not leaner than 1:3 by volume of cement and sand or as shown in the drawing. The mortar shall be filled and pressed into the properly raked out joints before giving the required finish. The pointing shall be ruled type for which it shall, while still green, be ruled along the centre with half round tools of such width as may be specified by the Engineer. The superfluous mortar shall then be taken off from the edges of the lines and the surface of the masonry shall be cleaned of all mortar. The work shall conform to provisions of IS: 2212. Raised pointing which projects beyond the face of stone, brick or block is likely to get damaged due to floods or carbonation process and hence should be avoided.

404.2.5 *Plastering*

404.2.5.1 Plastering shall be done only where shown in the drawing. Sacrificial plastering, which means an additional layer of plastering, may be done, if necessary, only in selected parts of the structures, situated in fast flowing rivers or in severely aggressive environment.

404.2.5.2 Plastering shall be started from top and worked downwards. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4.0 m apart to act as gauges and guides in applying the plaster. Prior to laying plaster, the surface of the wall should be wetted. The mortar shall be laid on the wall between the screeds using the mason's wooden float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm or 75 mm at a time. Finally, the surface shall be finished off with mason's wooden float. Metal floats shall not be used. When recommencing the plastering beyond the work suspended earlier, the edges of the old plaster shall be scrapped clean and wetted before plaster is applied to the adjacent areas. No portion of the surface shall be left out initially to be patched up later on. Plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required by the Engineer. The average thickness of the plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm. Any cracks which

appear in the surface and all portions which sound hollow when tapped or are found to be soft or otherwise defective shall be cut out in rectangle shape and redone as directed by the Engineer.

404.2.6 *Curing*

404.2.6.1 Green work shall be protected from rain by suitable covering. Masonry work in cement mortar shall be kept constantly moist on all the faces for a period of seven days. Brick work carried out during the day shall be suitably marked indicating the date on which the work was done, so as to keep a watch on the curing period. The top of masonry shall be left flooded with water at the close of the day's work. Curing shall be done carefully so as not to disturb or wash out green mortar. In case of composite mortar, curing should commence two days after laying of masonry and shall continue for seven days.

404.2.6.2 Curing in hot weather has to be done for all finished or partly completed work shall be covered and wetted in such a manner so as to prevent rapid drying of the work.

404.2.6.3 Curing of finishes shall be started as soon as mortar used for finishes such as pointing/plastering has hardened sufficiently so as not to be damaged during curing. The curing shall be done for a period of at least seven days

404.2.6.4 During the period of curing, masonry work and plastering shall be suitably protected from all damages. At the close of the day's work or for any other period of cessation of work, watering and curing shall have to be maintained. Should the mortar perish, i.e., become dry, white or powdery through neglect of curing, work shall be pulled down and rebuilt. If any stain appears during watering, the same should be removed from the surface.

404.2.7 *Jointing Old and New Work*

Where fresh masonry is to join with masonry that is partially or entirely set, the exposed joining surface of the set masonry shall be cleaned, roughened and wetted so as to effect the best possible bond with the new work. All loose bricks and mortar or other materials shall be removed. In the case of vertical or inclined joints, it shall be further ensured so that proper bonds between the old and new masonry is obtained by interlocking the bricks. Any portion of brick work that has been completed shall remain undisturbed until thoroughly set.

Where future extension is contemplated, arrangement suitable for developing bond between old and new masonry shall be made at the outset.

404.2.8 In case of sharp comer, especially in skew bridge, a flat face of 100 mm shall be provided so as to have proper and bonded laying of bricks.

404.2.9 Finishing of work: All brick work shall be finished in a workman-like manner with thickness of joints and manner of striking or tooling indicated as above or as shown in the drawing or described in the specifications.

404.2.10 For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned, and wetted. The mortar for finishing shall be prepared as per Clause 404.1.2

404.2.11 *Condition of Equipment*

All equipment used for mixing or transporting mortar and bricks shall be cleaned and free from set mortar, dirt or other injurious foreign substances.

404.3 Stone Masonry

404.3.1 Rubble Stone Masonry shall conform to the requirements of IS: 1597 (Part-I). Ashlar masonry shall conform to IS 1597(Part II). Dressing of Natural Building Stone shall be done as per IS: 1129.

404.3.2 *Type of Masonry*

For bridge works, generally, coursed rubble stone masonry (first sort) shall be used. For facing work, Ashlar masonry may be used if required. Random rubble stone masonry shall not be allowed in bridges except in the construction of return wall and toe wall upto 5.0 m height only. The actual type of masonry used for different parts of structures shall be as specified on the drawings. For facing work, ashlar masonry shall be used where indicated on the drawings.

404.3.3 *Size of Stones*

The size of stones shall be as per IS: 1597 (Part-I) or IS: 1597 (Part-II) as applicable for Rubble and Ashlar masonry respectively.

404.3.4 *Laying*

404.3.4.1 Quarry stones shall be hammer dressed on the face, the sides and the bed as per IS:1129. The masonry work shall be laid to lines, levels, curves and shapes as shown in the plan. The height in each course shall be kept the same and every stone shall be fine tooled on all beds, joints and faces, full and true. The exposed faces shall be gauged out, grooved, regulated and sunk or plain moulded as the case may be. The faces of each stone between the draft be left rough as the stone comes from quarry except where sacrificial layer is to be provided or plastering is resorted to due to aggressive environment.

404.3.4.2 Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.

404.3.4.3 Stratified stones must be laid on their natural beds. All bed joints shall be normal to the pressure coming on them.

404.3.4.4 Stones in the hearting shall be laid on their broadest face, which gives better opportunity to fill the space between stones. Hearting stones shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. Plum stones shall be provided at about 900 mm centre to centre to ensure proper bond between successive courses.

404.3.4.5 The courses of the masonry shall ordinarily be predetermined. They shall generally be of the same height. Where there is to be variation in the height of courses, larger courses should be placed at lower level, with height of courses decreasing gradually towards the top of the wall. The height of a course shall not be less than 160 mm. The practice of placing dry mortar on the course and pouring water on it to fill up gaps between stones is not allowed for cement mortar since it segregates. Mortar may be fluid mixed thoroughly and then poured in the joints. No dry or hollow

space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar.

404.3.4.6 In tapered walls, the beds of the stones anti the planes of courses should be at right angles to the batter. In case of bridge piers having batters in both sides, the courses shall be horizontal.

404.3.4.7 The bed, which is to receive the stone, shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately on placement and solidly embedded in mortar before it has set. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. When the foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into rock snugly, when pressed down in the mortar bedding over the rock. No hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with the mortar. For masonry works over rock, a levelling course of cement concrete M-20 grade and having minimum average thickness 150 mm shall be laid over rock and then stone masonry work shall be laid. The quantity of mortar consumed per cubic meter of various types of masonry are generally as below:

i) Ashlar masonry - 0.08 cum to 0.18 cum
ii) Coursed rubble masonry - 0.25 cum to 0.35 cum
iii) Random rubble masonry - 0.25 cum to 0.35 cum

404.3.4.8 Face works and hearting shall be brought up evenly but the top of each course shall not be levelled up by the use of flat chips.

404.3.4.9 For sharp corners, especially in skew bridges, through stone shall be used in order to avoid spalling of corners.

404.3.4.10 In case any stone already set in mortar is disturbed or the joints broken, the stone shall be taken out without disturbing the adjoining stones and joints, the mortar and stones thoroughly cleaned from the joints and the stone reset in fresh mortar. Attempt must never be made to slide one stone over another already laid fresh.

404.3.4.11 Shaping and dressing shall be done before the stone is laid in the work. No dressing and hammering which may loosen the masonry shall be permitted after it is, once placed. It is, therefore, advised that all-necessary chases for joggles, dowels and cramps should be formed before hand.

404.3.4.12 Through bond stones shall be provided in masonry upto 600 mm thickness. In case of masonry above 600 mm thickness, a set of two or more bond stones overlapping each other atleast by 150 mm shall be provided in a line from face to back.

404.3.4.13 In case of skew bridges and for cut and ease water, the acute angle at the corners shall not be less than 45 degrees. In case the smaller angle cannot be avoided then a flat face of 100 mm be provided.

404.3.4.14 While carrying out masonry work, templates prepared to the correct shape and approved by competent authority shall be used to ensure correct batter as well as correct shape of masonry specially cut and ease water end. The finished work shall be checked at every stage by the competent authority to ensure that it has the correct shape and batter as required by design.

404.3.5 *Bond*

404.3.5.1 Sufficient transverse bonds shall be provided by the use of bond stones extended from the front to the back of the wall and in case of thick wall from outside to the interior and vice versa. In the later case, bond stones shall overlap each other in their arrangement. Such overlap shall not be less than 150 mm. Minimum length of each bond stone shall be 450 mm. Bond stone or a set of bond stones shall be provided at 1.5 m to 1.8 m apart clear in every course and staggered in layer.

404.3.5.2 In case, long headers are not available, precast headers of M-15 concrete shall be used. Cast in-situ headers are not permitted.

404.3.5.3

i) Stone shall break joint on the face for at least half the height of the course and the bond shall be carefully maintained throughout.
ii) At junctions of wall, the stones at each alternate course shall be carried into each of the respective walls so as to unite the work thoroughly.
iii) The practice of building two thin faces tied with occasional through stones and filling-up the middle with small stuff or even dry packing must be strictly prohibited.
iv) All quoins at the angles of the opening shall be made from selected stones. These shall be carefully shaped and laid alternately as long and short quoins.

404.3.5.4 All vertical joints shall be truly vertical and staggered as far as possible. Distance between the nearer vertical joints of upper layer and lower layer shall not be less than half the height of the course.

404.3.5.5 All connected masonry in a structure shall be carried up nearly at one uniform level throughout but when breaks are unavoidable, the masonry shall be racked in sufficiently long steps for facilitating joining of old and new work the stepping of racking shall be around 45 degrees with horizontal.

404.3.6 *Pointing*

Pointing shall be same as given in Clause 404.2.4. The thickness of joints shall not be less than 3 mm for Ashlar masonry. The maximum thickness of joints in different works shall be as follows:

Coursed rubble	-	20 mm
Block work	-	12 mm
Ashlar masonry	-	6 mm

404.3.7 *Curing*

Curing of stone masonry shall be done as given in Clause 404.2.6.

404.4 Concrete Block Masonry

404.4.1 Only solid concrete blocks of normal weight conforming to IS : 2185 Part-I, with minimum compressive strength of 20 MPa shall be used for bridge works.

404.4.2 *Sizes of Blocks*

The thickness of concrete block shall not be less than 200 mm and the width shall also be not less than 200 mm. The density of concrete block shall not be less than 2.2 ton/cum.

404.4.3 *Laying*

404.4.3.1 The bed, which is to receive the block, shall be cleaned wetted and covered with a layer of fresh mortar. The masonry work shall be laid to lines, levels, curves and shapes as shown in the plan. In battered sections, the beds of blocks and the plane of courses shall be horizontal. Face blocks for such sections shall be manufactured specially for the purpose.

404.4.3.2 The block shall be soaked in water for at least 15 minutes before laying to prevent absorption of water from mortar.

404.4.3.3 The concrete block masonry shall be constructed generally like fine tooled Ashlar masonry. Each block must be fitted into its place dry in order that discrepancy of figure may be discovered and corrected before it is finally laid in mortar and settled in bed. The block shall be laid full in thin mortar. the bed and side joints being not more than 15 mm in thickness. Each block shall be struck with a wooden mallet when laid in place in mortar to bring it to solid bearing as to bed and joints. All visible edges shall be quite free from chippings. The courses shall be horizontal and side joints vertical throughout unless otherwise indicated in drawings. Joints shall be struck. For bond, face blocks shall be laid header and stretcher alternately unless otherwise ordered by the Engineer, the header being arranged to come as nearly as possible in the middle of stretchers below. The blocks in the courses above and below shall break joints for about half the height of the course and bond shall be carefully maintained throughout section.

404.4.4 While carrying out masonry work, templates prepared to the correct shape and approved by competent authority shall be used to ensure correct batter as well as correct shape of masonry specially cut and ease water end. The finished work shall be checked at every stage by the competent authority to ensure that it has the correct shape and batter as required by design.

404.4.4.1 In case of skew bridges and for cut and ease water, the acute angle at the corners shall not be less than 45 degrees. In case, the smaller angle cannot be avoided then a flat face of 100 mm be provided.

404.4.5 Curing for block masonry shall be done as given in Clause 404.2.6.

404.5 Arches

404.5.1 Arch bridges may be constructed where foundation conditions are such that there is no risk of settlement. Semi-circular or segmental arches shall be built with concrete blocks, bricks or stone masonry. The arch work shall be carried up from both ends simultaneously and keyed in the centre. After erection of arch ring, the haunches shall be loaded by filling up to the crown level. Only non- expansive soils shall be used as fill material between the spandrel walls. The minimum depth of fill above crown shall be 300 mm. A full-scale shape of arch be laid on a levelled platform near the construction site and size of each stone and mortar thickness be marked. Then the stones be

cut or blocks made accordingly. In the outer rings of the arch the alternate stone shall have long length and short length as shown in the **Fig.4.2**. Remaining stones/blocks in the inner part of the arch as far possible may have uniform length. The number of courses and the size of the voussoirs shall be shown on the plans. The plan should indicate the order in which voussoirs shall be placed. Voussoirs shall be full size throughout and shall have bond not less than their thickness. Beds shall be properly adjusted to bring them to radial planes. Radial joints shall be in planes parallel to the transverse axis of the arch. The intrados face shall be dressed sufficiently to permit the bricks, stones or block to rest properly upon the centering. The bricks/stones/blocks of the spandrel wall at their junctions with the extrados of the arch shall be cut to fit in the curvature of the arch **(Fig.4.2)**.

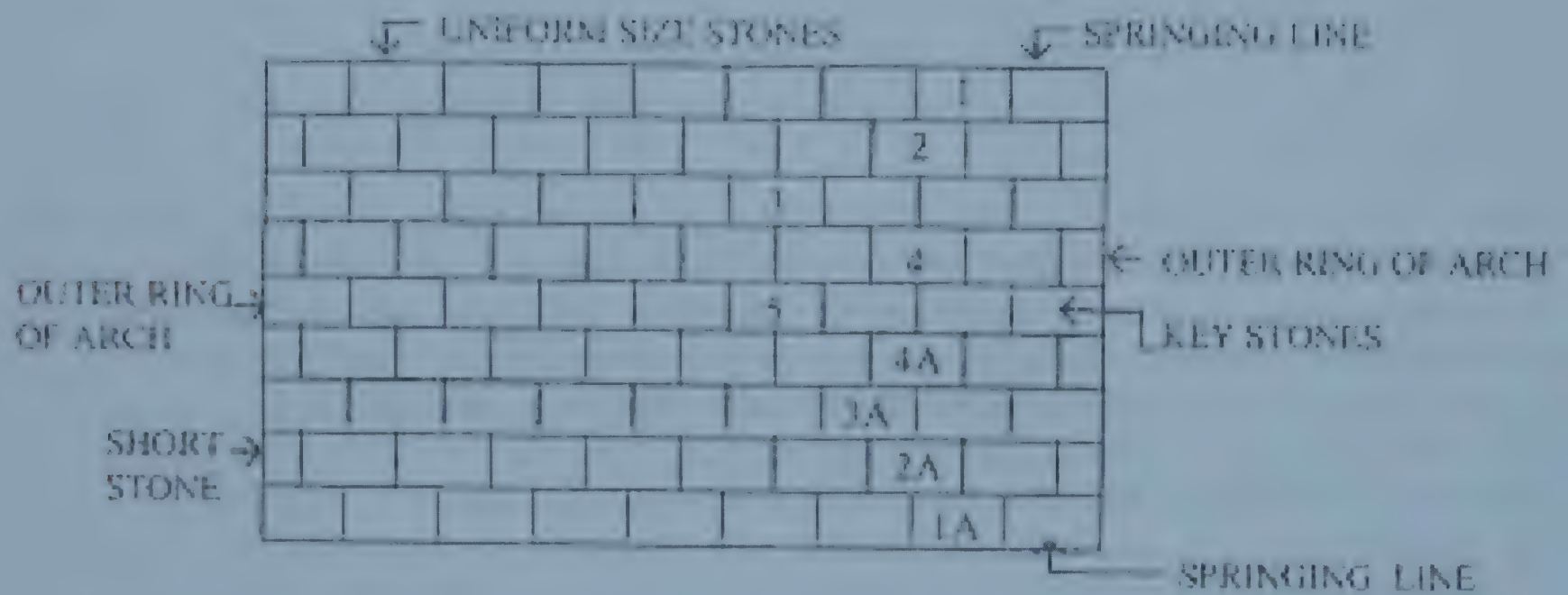

Fig. 4.2 Schematic Plan Showing Arrangement of Stones/Block in Arch Construction

Note: *Number indicate the order of placing the rows of voussoirs.*

404.5.2 The work shall be carried out symmetrically about the crown, units being laid in full mortar beds and the joints grouted where necessary. Pinning by the use of spalls or such material of any description shall not be permitted. Each stone must first be fitted dry, in order that any inaccuracy may be discovered and corrected by stone cutter before it is finally laid into mortar and settled in its bed.

While carrying out haunch filling and cushioning (and also while removing these during repairs) care shall be taken to ensure stability of arch and also to avoid unsymmetrical loading on the substructure and arch. Cross camber shall be provided in the top surface of concrete of haunch filling and corresponding drain holes in the face wall to facilitate easy drainage of seepage water.

404.5.3 *Scaffolding*

The scaffolding in general shall be sound and strong and shall be able to withstand all loads likely to come upon it. The holes left in masonry work for supporting the scaffolding shall be filled and made good. For design considerations of scaffolding, the IRC:87 may be referred to.

404.5.4 *Centering*

404.5.4.1 The successful completion of an arch largely depends on the design, construction and stripping of the centering. Therefore, considerable thought should be given to the method used in supporting an arch ring. For design considerations, the IRC:87 "Guidelines for Formwork, Falsework and Temporary Structures for Road Bridges" may be referred.

***Note**: Centering for special condition shall be designed by experienced Engineer who has the requisite theoretical and practical knowledge in this field.*

404.5.4.2 The number of full sets of centering required depend upon the number of arch spans. For two or three spans, two or three sets may be used. For five or more spans, three or more sets may be used depending on the location of the abutment pier. For wide bridges, it may sometimes be more economical to build the centering for half width of the bridge and move sideways for the other half. However, reference may be made to IRC:87 "Guidelines for Formwork, Falsework and Temporary Structures for Road Bridges".

404.5.5 *Stripping*

404.5.5.1 Wedges should be struck in pairs from the crown outwards to the springing line loosening them gradually without shock to the arch ring. About half the wedges can be removed in seven days and used in the adjoining arch. Centering should not be struck earlier than 3 weeks. Arches with higher ratio of rise to span can be stripped earlier than those with lower ratio. All braces except those that may be required for supporting scaffolding plank can be removed. For high arches, stripping should commence at the top taking down tier by tier.

404.5.5.2 In multiple span arch bridges, centering must not be struck and stripped before the adjoining arch is built. Sometimes it is required that one or two arches may be kept undisturbed between the arch last built and the arch being stripped off.

404.5.5.3 Striking of Centering

Centering shall not be struck until the masonry has sufficiently hardened to maintain its own weight and the haunch portions are filled to half the rise in circular arches and 1/3 rise in segmental arches. Where it is intended to reuse the formwork, it shall be cleaned and made good to the satisfaction of the engineer.

405 EXPANSION GAP

405.1 In the case of long walls, an expansion gap of 40 mm shall be provided for every 30 m length of the wall. The gap should be filled with a pre-moulded bituminous sheet or any suitable flexible material.

405.2 Where foundations of abutments and returns walls are at different levels, a gap of at least 40 mm in width shall be left to separate them.

406 FLOOR PROTECTION WORKS

For floor protection works, IRC:89 "Guidelines for Design and Construction of River Training & Control Works for Road Bridges" may be referred to.

Annexure-A

(Ref. Clause 400)

SPECIAL PRECAUTIONS FOR CONSTRUCTION OF MASONRY DURING FREEZING WEATHER

A.1 Storage

Masonry materials should be stored and protected at the job site to prevent damage from wet, cold or freezing weather. Bagged materials and masonry units should be stored elevated to prevent migration of moisture from the ground and covered to protect the sides and tops. Consideration should be given to the method of stock piling sand to permit heating of the materials, if required.

A.2 Forms and Shoring

Provide substantial and tight forms to prevent leakage of mortar or grout. Brace or shore forms to maintain position and shape. Do not remove forms or shoring until masonry has hardened sufficiently to carry its own weight and any other temporary loads that may be placed on it during construction.

A.3 Surface Conditions

Ice or snow that has formed on the masonry bed shall be thawed by application of heat. Apply heat carefully until top surface is dry to the touch. Any section of completed masonry work that is deemed frozen and damaged shall be removed before continuing construction of that section

A.4 Condition of Masonry Units

Use only dry masonry units except as permitted below. Wet or frozen masonry units shall not be laid. Wetting of concrete masonry units shall not be permitted.

For brick masonry units used in cold weather construction, initial rates of absorption may range to a maximum of 35 mg. When sprinkling is required to achieve proper absorption rates, heated water shall be used. Water shall be above 20^{O} C when temperature of units is above freezing point and above 55^{O} C when temperature of units is below freezing point.

A.5 Construction Requirements

Construction Requirements				
Work day Temperature	Temperature for construction requirement		Protection Requirement	Protection of completed work
	Sand or Water	Sand and Water		
	(+) 4°C to (+) 50°C	(+) 4°C to (+) 50°C		
(+) 0°C to (+) 4°C	(+) 4°C to (+) 50°C	(+) 4°C to (+) 50°C	-	During construction the masonry shall be protected from rain or snow for 24

	.			hours by covering it with weather-resistive membrane.
(-) 4° C to (+) 0° C	(+) 4°C to (+) 50°C	(+) 4°C to (+) 50°C	Maintain mortar temperature above freezing point	During construction the masonry shall be protected from rain or snow for 24 hours by covering it with weather-resistive membrane.
(-) 7°C to (-) 4°C	(+) 4°C to (+) 50°C	(+) 4°C to (+) 50°C	Maintain mortar temperature above freezing point. Provide source of heat on both sides of wall. Employ wind brake if wind speed > 25 kmph	Masonry shall be completely covered with insulating blankets and protected for 24 hours.

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/ Manual etc. from the date specified therein)

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